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Islands of Automation in Shipbuilding

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ISLANDS OF AUTOMATION IN SHIPBUILDING

BY

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ABSTRACT

Many experts believe that automation techniques, applied independently of corresponding system improvements, will produce only limited results in productivity improvement. However, a number of opportunities are available in shipbuilding for substantial productivity improvement by implementing stand-alone automation technologies (sometimes called "islands of automation").

The challenge to increase the level of automation in shipbuilding can best be met by matching proven technologies. with those opportunities that justify automation. Proven automation technologies are readily available and government programs are in place to provide the shipbuilder with both financial and technical support. Effective implementation of automation technologies can be greatly enhanced by following a few basic points in project development and control.

Program results at Bath Iron Works have demonstrated that implementation of "islands of automation" can result in substantial productivity improvement.

ISLANDS OF AUTOMATION
IN SHIPBUILDING

INTRODUCTION

A recent article written about u.S. shipbuilding productivityivity states that automation technology; applied independently of corresponding system improvements, such as group technology andand process lanes, will usually produce only limited results in productivity improvement.[1] While I generally agree with this conclusion, our own experience with production automation programs at Bath Iron Works (BIW)[2,3] clearly demonstrates that a number of excellent opportunities are available in shipbuilding for substantial productivity improvement by implementating stand-alone (i.e. system independent) automation technologies (which are referred to in this report as "islands of automation").

A major government commitment exists today for improving shipbuilding industry productivity, mainly through the development and implementation of automation technology and system innovations. This commitment is emphasized in a number of government sponsored publications which include the National Shipbuilding Research

Program (NSRP) Long Range Productivity Plan (Figure l), dated September, 1984, and the Naval Sea Systems Command (NAVSEA) Integrated Robotics Program Annual Report (Figure 2), dated December, 1984. With this commitment to improve shipbuilding productivity, the shipbuilding industry presently has an outstanding opportunity to obtain substantial government support, both technical and financial, for the implementation of "islands of automation" in ship construction.

THE CHALLENGE

A major challenge of the shipbuilding industry for improving productiuity is to increase the application of proven automation technologies for ship construction. In this regard, approximately 6,500 robots are presently at work in other U.S. industries, performing welding, painting, inspection, assembly, and machine loading operations,[4] yet I am not aware of a single robot actually performing work in shipyards today on a continuous production basis. Furthermore, of some twenty shipbuilding/weapons manufacturing robotics projects listed in the NRVSEA Integrated Robotics Program, only two are identified as being performed by shipyards.[5]

The U.S. shipbuilding industry itself recognizes and emphasizes the need to concentrate on implementation of proven technologies. For instance, the NSRP Long Range Productivity Improvement Plan states that "the immediate emphasis (of this Plan) must be the implementation of existing technologies that have already demonstrated their effectiveness in foreign applications or in other segments of industry within the country."[6] The

Department of Defense also emphasizes the implementation of proven technologies in the DoD statement of principles for the Manufacturing Technology Program, dated March 14, 1980, which states that "technical feasibility has been previously demonstrated before procurement-funded manufacturing technology projects are initiated." [7]

The challenge to increase the level of automation in shipbuilding can best be met by matching proven automation technologies with those operations that justify automation, and by effectively managing these automation programs to ensure obtaining the desired results. This report emphasizes how BIW is meeting this challenge in its own automation programs.

IDENTIFICATION OF AUTOMATION TECHNOLOGY OPPORTUNITY AREAS

The identification of appropriate operations for automation in shipbuilding can be simplified by adopting an informal evaluation procedure which has been very successful at BIW. BIW first identifies those manufacturing operations having high labor content and (generally) consisting of low technology processes. Typical of such operations in shipbuilding are those of manual layout, painting, cutting, burning, welding, material handling, etc. To ensure that the maximum number of candidate operations for automation are identified, this initial phase should be performed <u>without</u> consideration of available technologies. Applicable government funded reports can also be used effectively to augment the findings of self-assessment studies for identifying the candidate operations. One such report used extensively by BIW for this purpose is the Maritime Administration Technology Survey of Major U.S. Shipyards, dated July, 1978.[8] This survey rates the average level of technology of thirteen major U.S. shipyards (Table 1) for seventy-two distinct shipbuilding operations against a consistent set of internationally applied standards.

The final phase of this recommended evaluation process is to identify suitable automation technologies for each of the candidate operations, and to select the one technology that is considered to be most effective in improving productivity. In this matter, BIW has relied entirely on technical proposals from leading equipment manufacturers to identify and select sound automation systems (hardware and software).

The evaluation procedure described above resulted in the selection of a highly successful computer controlled sheetmetal fabrication system (Figure 3) to automatically produce sheetmetal parts for ventilation assemblies (Figure 4) at BIW. This same evaluation process also resulted in a recent BIW proposal to implement a robotics shapes fabrication system (Figure 5) for the automatic production of structural shapes (Figure 6). The selected robotics systern is projected to eliminate the low technology, labor intensive methods presently used for structural shapes fabrication, at the Bath shipyard (Figure 7).

KEY POINTS FOR PROGRAM SUCCESS

Effective implementation of automation technologies can be greatly enhanced by adhering to the following key points for program success :

- Use <u>fully proven</u> technologies. This allows the shipbuilder to concentrate his efforts on application, rather than development, of automation technology, thereby increasing the chance of program success. The two BIW automation programs combine <u>proven</u> equipment technology and specialized computer software to provide effectively integrated systems. The success of the sheetmetal fabrication system has been demonstrated by reducing ventilation component fabrication labor by 54%. I am also confident that the proposed robotics shapes processing system will be equally successful at reducing fabrication labor.
- Limit the financial risk of the program. With the generally high levels of capital investment associated with automation systems, financial risks to the individual shipyard can be substantial. These risks can be reduced to acceptable levels through cost sharing of such programs with the government under either the Maritime Administration Ship Producibility Research Program or the Navy Manufacturing Technology Program. A third program, the navy Industrial Modernization Incentive Program (IMIP), provides financial incentives to contractors for increasing the level of productivity related capital investment. Although this program does not provide for government cost sharing, it does reduce financial risk by allowing the contractor a larger share of resulting project savings.

- Plan for future technology enhancements. If anticipated technical developments can be incorporated in the automation system at a later date, the original system should be designed with sufficient flexibility to readily add such enhancements. Typical enhancements might include the addition of computer aided design capability to a computer controlled machine, or the addition of automated material handling to an automatic fabrication operation. Regardless of the nature of these enhancements, initially providing for their incorporation at a later date will usually result in substantial increases in productivity, with minimum additional cost and effort. For instance, BIW is developing the Robotics Shapes Processing System software to readily accept a computer aided design and manufacturing capability (Figure 8) at a later date.
- Develop the project schedule around measurable and attainable results-oriented milestones. This is the most critical item for program success because it provides the basic control for both schedule and cost performance, and is especially necessary for those projects where subcontractor progress payments are related to performance against discrete mile-stones. The subcontractor should participate directly in the project schedule development process at the outset to ensure the mutual agreement between the shipbuilder and subcontractor that all project milestone target dates are achievable, and that there are a sufficient number of interim reviews specified in the schedule to measure subcontractor progress. These points for effective project schedule development are reflected in the, BIW project (schedule for the robotics structural fabrication system (figure 9).

- The major milestone tasks are broken down into a number of discrete and easily measurable sub-tasks. Also, where necessary, the schedule includes interim design reviews.
- The first project schedule task is the development of the system functional specifications. These specifications must clearly identify all operating requirements of the automation system before beginning the development of subsequent project tasks. Preparation of functional specifications for this program was accomplished jointly with the subcontractor to ensure an effective fit between the resulting system and the shipyard operating requirements.
- The highly technical tasks such as equipment design, software development, and system integration and test are the responsibility of the subcontractor, with BIW's efforts concentrated on program management, systems installation, and training. BIW considers that technology development should remain with those industries that are best equipped with the necessary technical expertise and resources for such work.

- o Establish a permanent organization at the outset of the program. It is vital that this organization be structured to ensure top management support, and include permanently assigned production and technical personnel throughout the program. The Robotics Shapes Fabrication Project Organization (Figure 10) meets these requirements by organizing under the Senior Vice President of Operations and by establishing a project implementation team with permanently assigned people from Systems (CAD/CAM), Industrial Engineering, Production Planning (Mold Loft), Plant Engineering, and Production.

Summary

Implementation of "islands of automation" in shipbuilding can generate substantial productivity improvement as demonstrated by our program results at BIW. Proven automation technologies are readily available and government programs are in place to provide the shipbuilder with both financial and technical support. Finally, the chance of automation program success can be greatly improved by following a few basic points in project development and control. The responsibility for increasing the level of automation in ship construction clearly rests with the shipbuilding industry.

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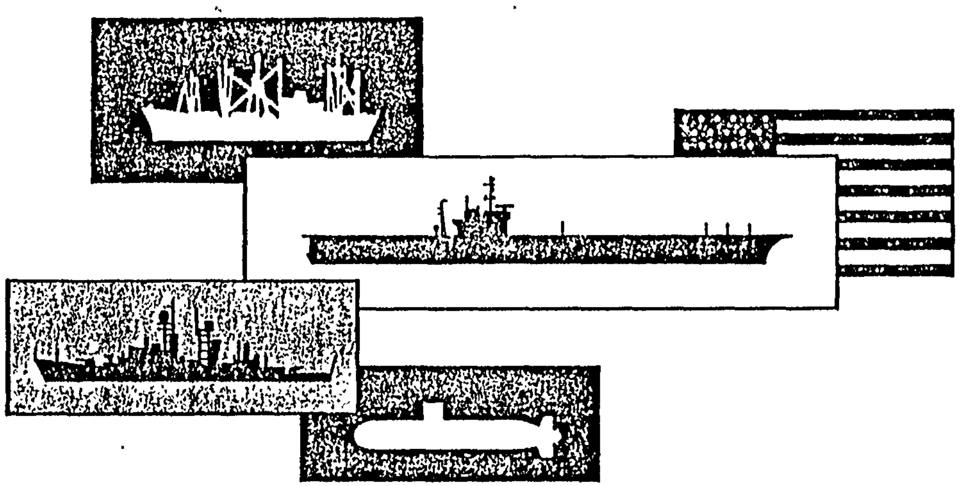
FIGURES

THE NATIONAL SHIPBUILDING RESEARCH PROGRAM LONG-RANGE PRODUCTIVITY IMPROVEMENT PLAN



PREPARED BY:

THE SHIP PRODUCTION COMMITTEE OF
THE SOCIETY OF NAVAL ARCHITECTS
& MARINE ENGINEERS

SEPTEMBER 1984

FIGURE 1

NAVSEA Technical Report
No. 450-90G-TR-0002

NAVAL SEA SYSTEMS COMMAND INTEGRATED ROBOTICS PROGRAM

ANNUAL REPORT
FISCAL YEAR 1984

OFFICE OF ROBOTICS AND AUTONOMOUS SYSTEMS
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DECEMBER 1984

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FIGURE 2

BIW COMPUTER CONTROLLED SHEETMETAL FABRICATOR SKETCH

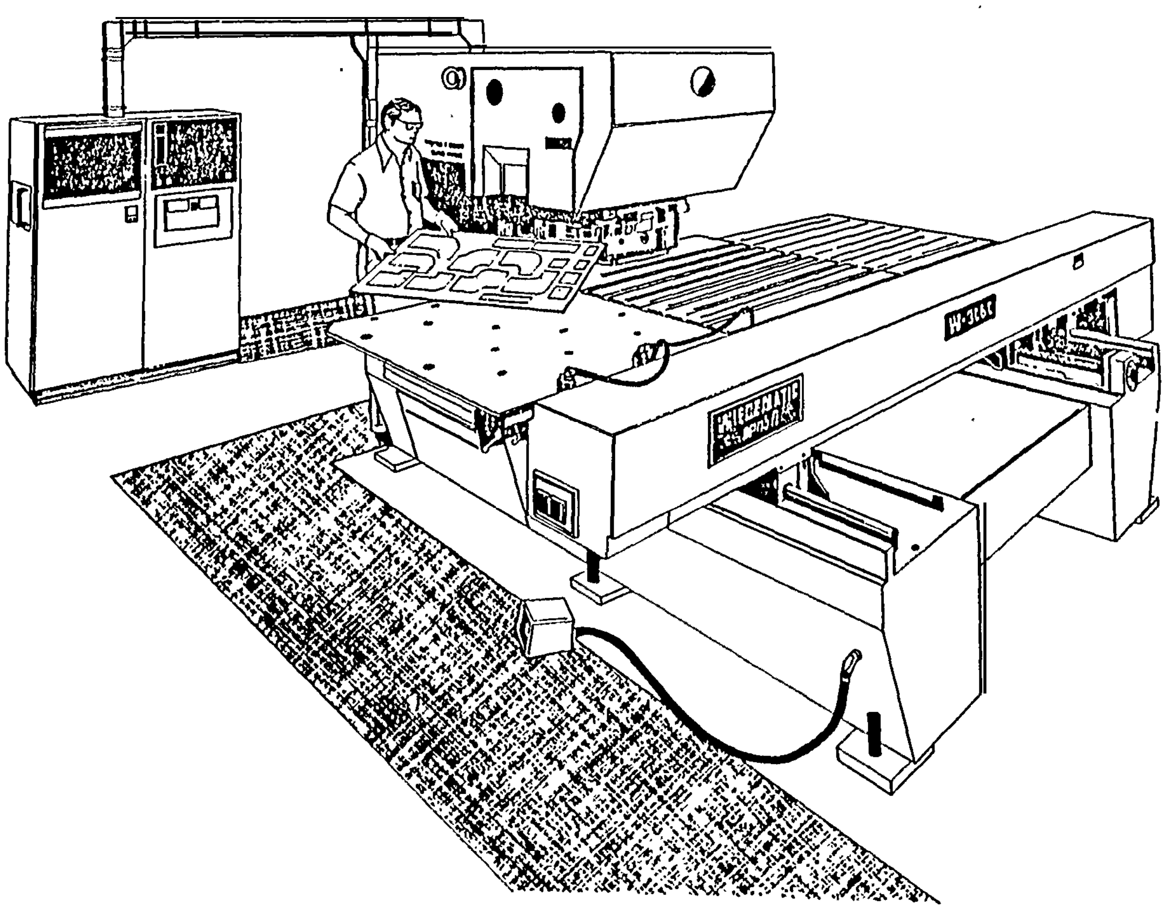
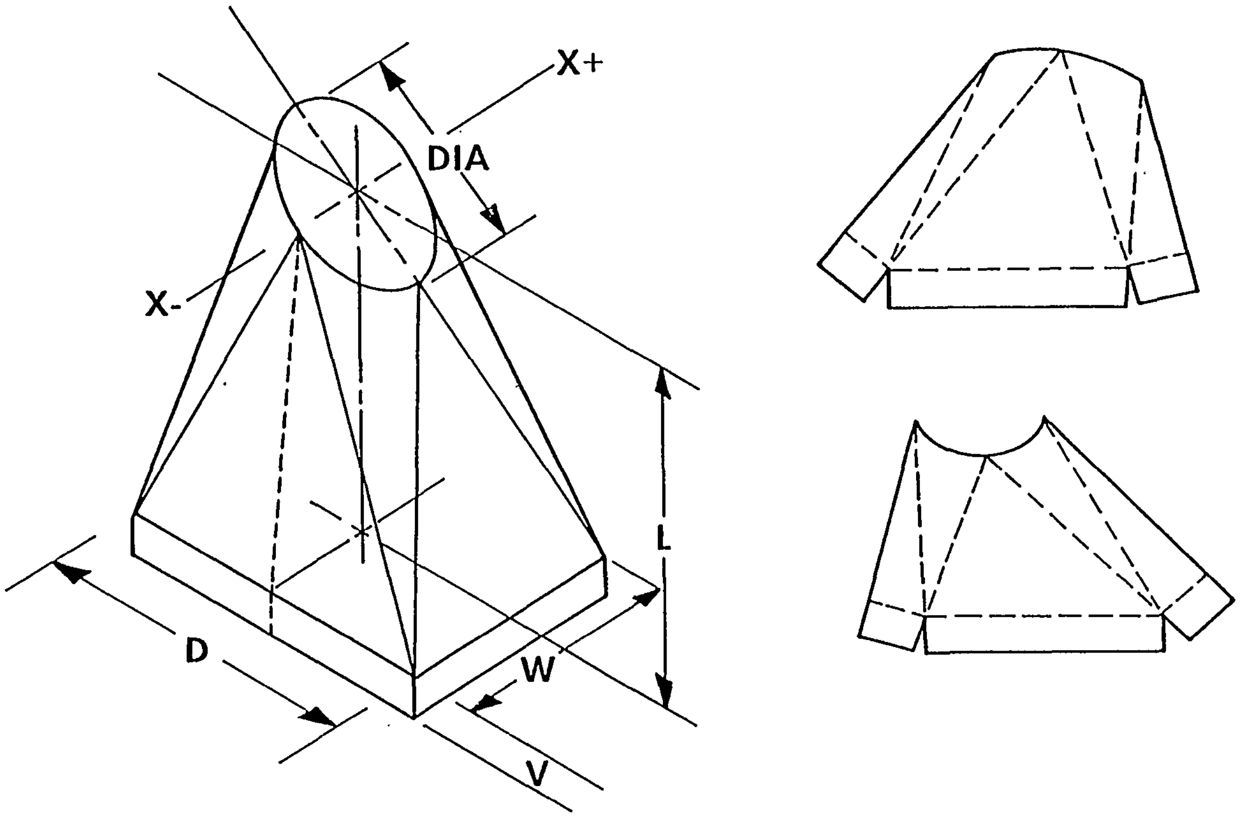


FIGURE 3

TYPICAL MARINE TYPE SHEETMETAL VENTILATION ASSEMBLY



TRANSITION - RECTANGULAR TO ROUND - SLANT TOP

FIGURE 4

GENERAL ARRANGEMENT OF ROBOTICS SHAPES PROCESSING SYSTEM

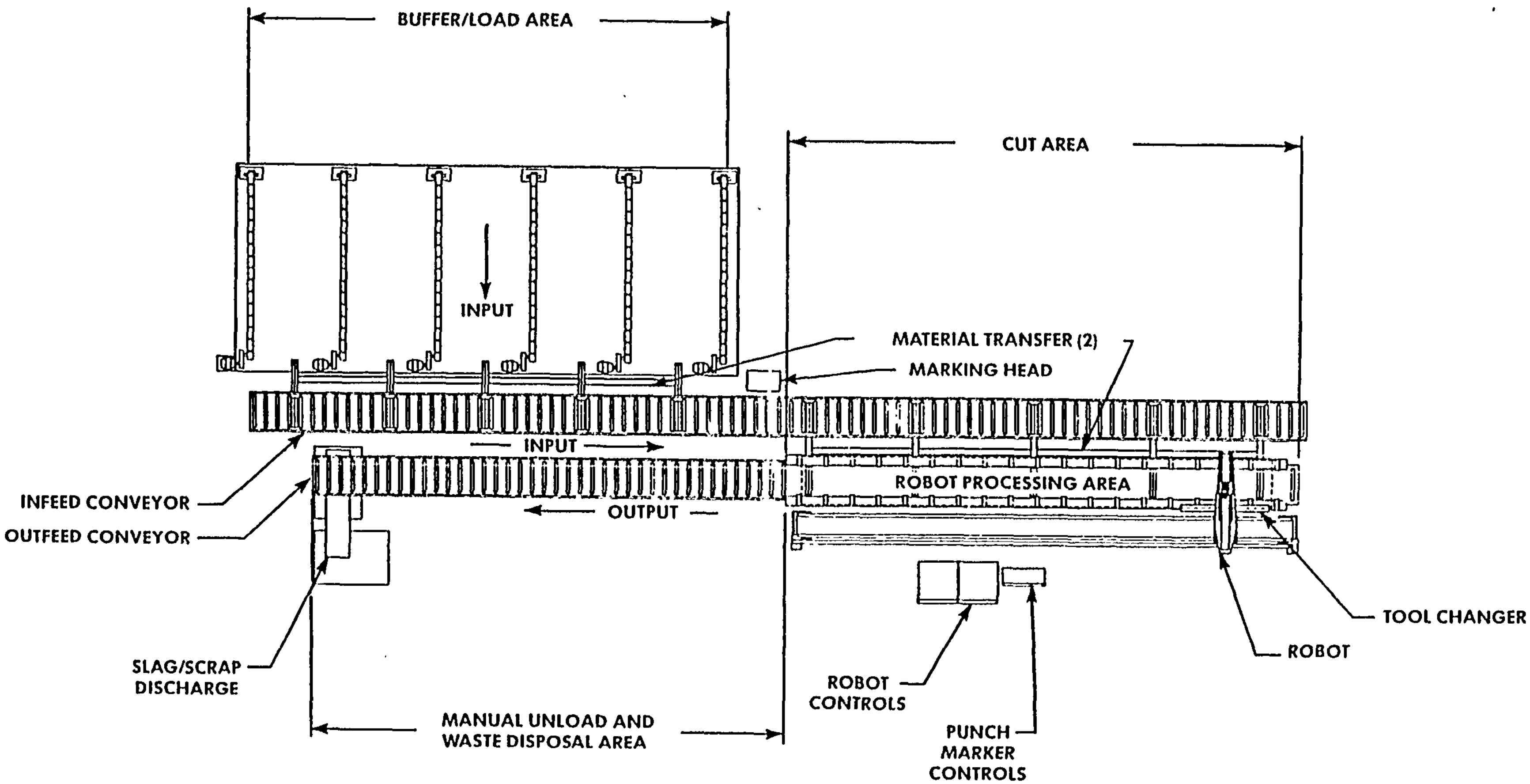
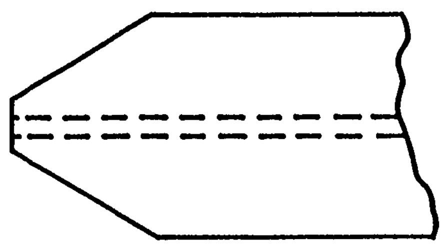
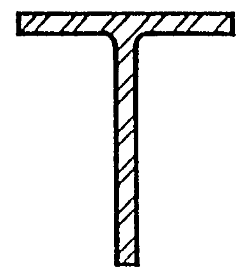


FIGURE 5

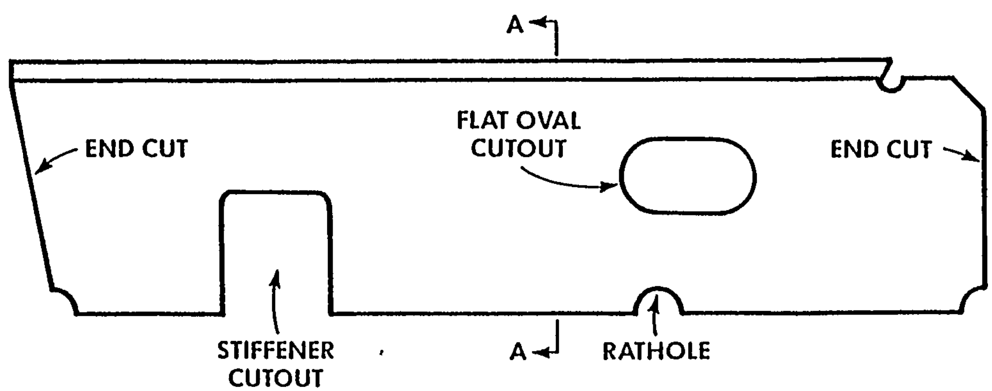
TYPICAL MARINE TYPE FABRICATED STRUCTURAL SHAPE



TOP VIEW



SECTION A-A



CUT TEE BAR

PRESENT AND PROPOSED SHAPES PROCESSING METHODS

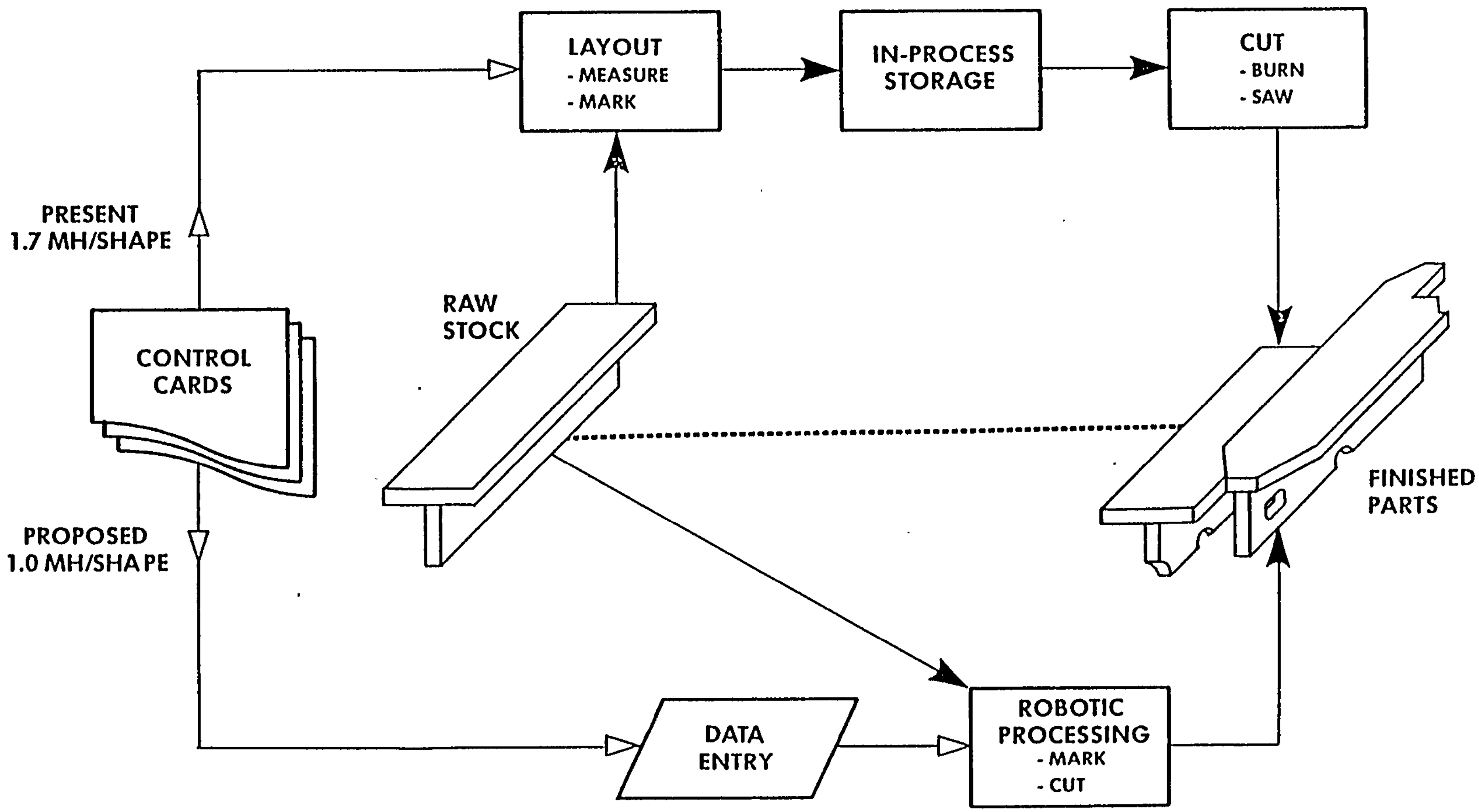


FIGURE 7

ROBOTICS SHAPES PROCESSING SYSTEM FLOW

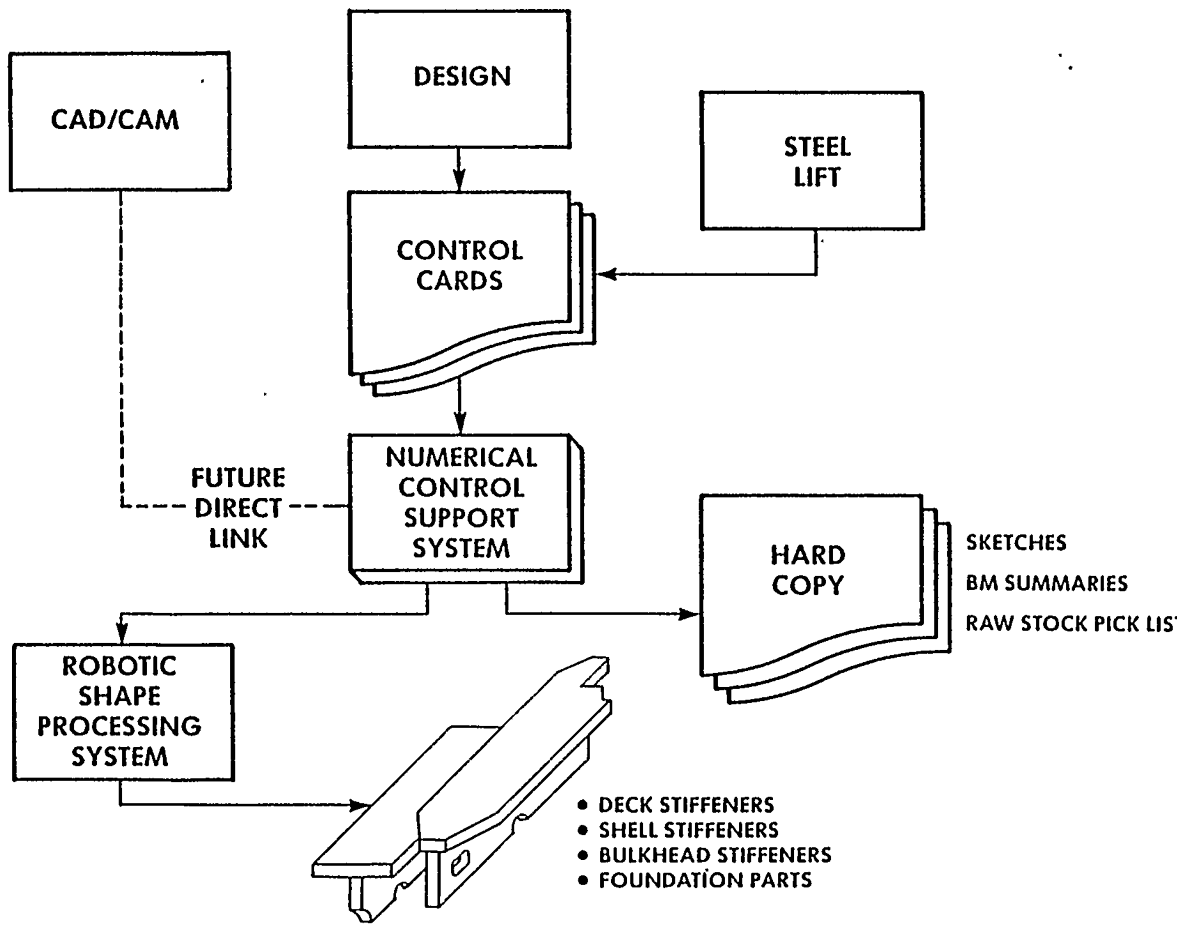


FIGURE 8

ROBOTICS SHAPES PROCESSING SYSTEM PROJECT SCHEDULE

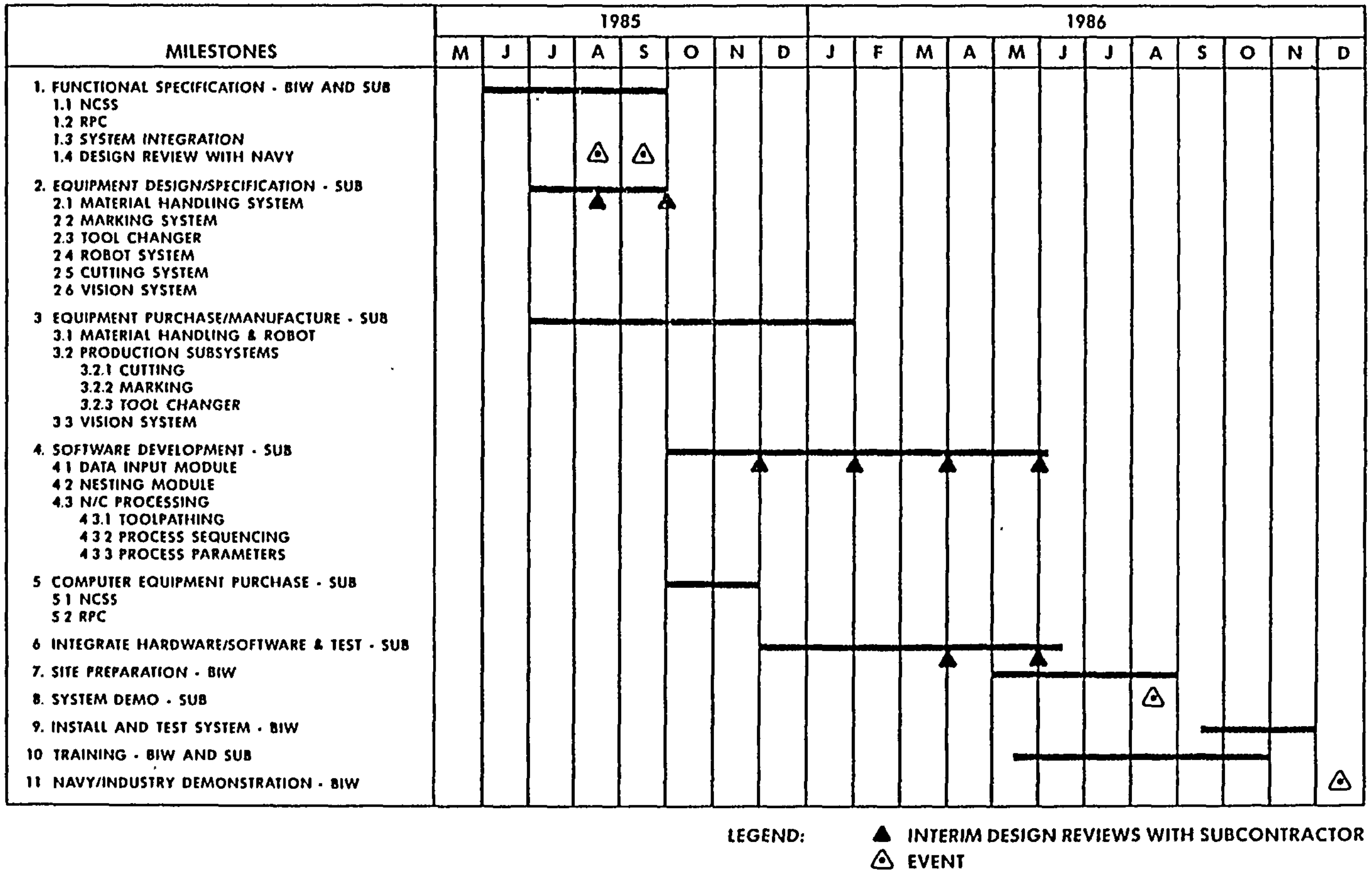


FIGURE 9

ROBOTICS SHAPES PROCESSING SYSTEM PROJECT ORGANIZATION

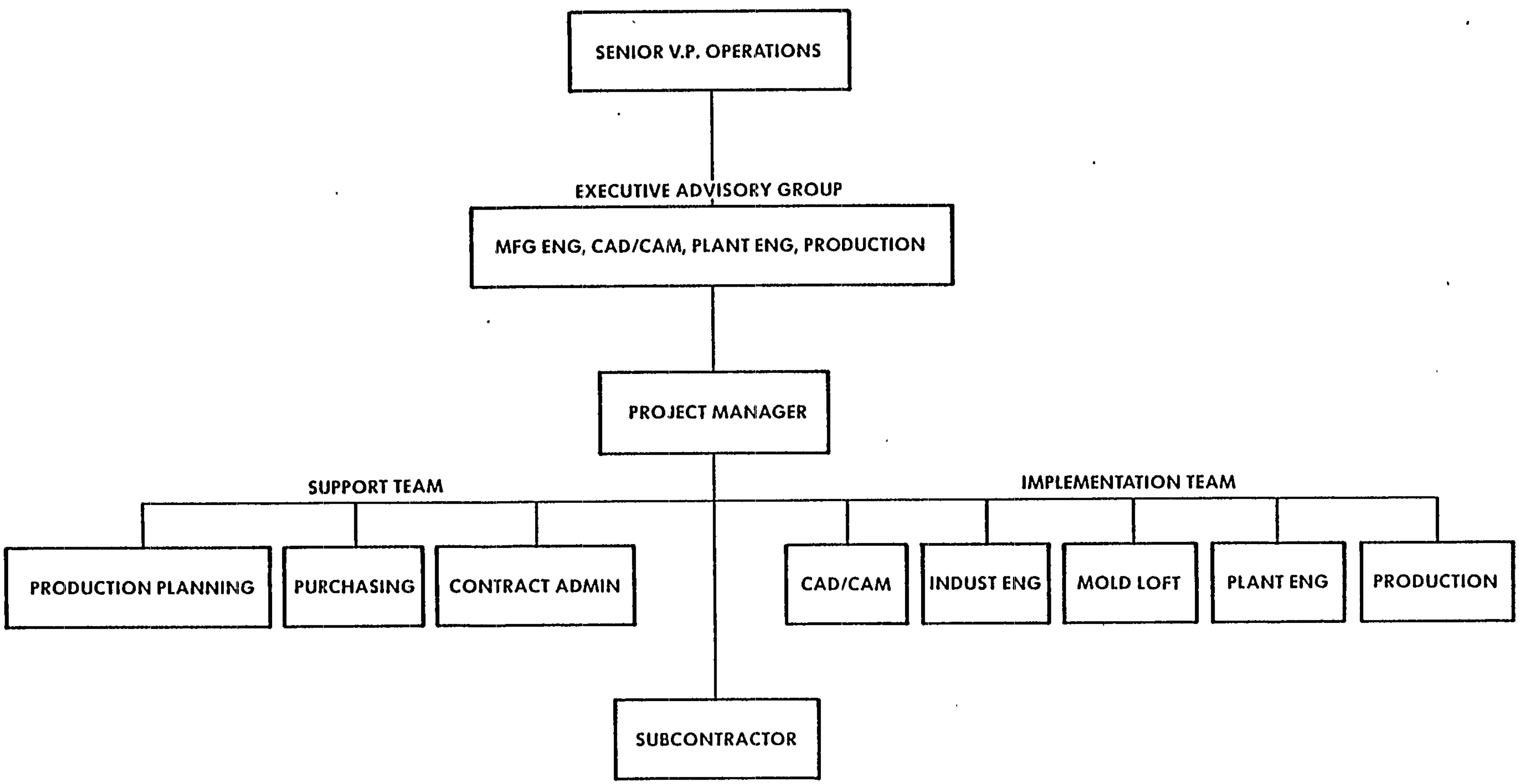


FIGURE 10

AVERAGE LEVELS OF TECHNOLOGY FOR THIRTEEN U.S. SHIPYARDS

STEELWORK PRODUCTION	AVG.	U.S. SHIPYARDS NO. AT LEVEL 1	2	3	4
A1 PLATE STOCK YARD & TREATMENT	2.7	0	4	9	0
A2 STIFFENER STOCKYARD & TREATMENT	2.2	1	8	4	0
A3 PLATE CUTTING	3.5	0	0	7	6
A4 STIFFENER CUTTING	$\boxed{1.5}$	6	7	0	0
A5 PLATE & STIFFENER FORMING	2.2	1	8	4	0
A6 SUB-ASSEMBLY		2	5	6	0

OUTFIT PRODUCTION & STORES	AVG.	1	2	3	4
B1 PIPEWORK	2.0	1	11	1	0
B2 ENGINEERING	1.9	3	8	2	0
B3 BLACKSMITHS	3.9	0	0	1	12
B4 SHEETMETAL	$\boxed{2.1}$	2	8	3	0
B5 WOODWORKING	—	—	—	—	—
B6 ELECTRICAL	2.3	0	10	2	1

TABLE 1

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